EVALUATION
OF THE
DETAILED CONTROL ROOM DESIGN REVIEW
PROGRAM PLAN

FOR

CAROLINA POWER AND LIGHT COMPANY'S
BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

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DCRDR PROGRAM PLAN EVALUATION
FOR THE CAROLINA POWER AND LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT
UNITS 1 AND 2

Science Applications International Corporation (SAIC) has evaluated the program for conducting a Detailed Control Room Design Review (DCRDR) submitted by the Carolina Power and Light Company (CP&L) for the Brunswick Steam Electric Plant (BSEP) Units 1 and 2. The purpose of the evaluation was fourfold: (1) to determine whether the plan would lead to a successful review; (2) to recommend to NRC whether a meeting with utility representatives or an in-progress audit should be conducted; (3) to provide a meeting or audit agenda where appropriate; and (4) to provide a basis for constructive feedback to the Carolina Power and Light Company. The specific document reviewed is listed as Reference 1.

Evaluation was conducted relative to the requirements of Supplement 1 to NUREG-0737 (Reference 2). Additional guidance was provided by NUREG-0700 (Reference 3) and Section 18.1,revision 0, of NUREG-0800 (Reference 4). This report provides the results of the evaluation.

EVALUATION OF PROGRAM PLAN

The program plan submitted by CP&L consists of 61 pages, supplemented by an appendix. The Program Plan consists of seven sections. The first section addresses the Review Plan and includes an introduction, background information, the structure of the DCRDR program, a glossary of terms and a listing of acronyms. Section 2 is devoted to management and staffing and identifies the positions that comprise CP&L support management and the DCRDR teams. The third section provides a detailed description of the technical approach which, in addition to an introduction, includes methodologies for the conduct of: Operating Experience Review, Control Room Surveys, System Functions and Task Analysis, Control Room Inventory, Verification of Task Performance Capabilities, and Validation of Control Room Functions. Section 4 addresses Human Engineering Discrepancy (HED) prioritization and correction. Section 5 presents a brief description of the CP&L documentation and document control plan. Section 6 presents a brief description of the planned contents of the Summary Report and a schedule for its submittal. Section 7 provides a preliminary enumeration of the steps anticipated during the DCRDR implementation phase. Finally, Appendix A describes a sample Human Factors Task Plan for review of an annunciator system.

1. Establishment of a Qualified Multidisciplinary Review Team

The program plan provides, via text and figures (2-1 and 2-2), a description of the DCRDR project team structure. Overall administration is provided by BSEP personnel. The responsibilities of top management have been defined so as to ensure that the review team activities can be coordinated with other improvement programs and that the review team will have freedom of action, access to required resources and technical support. Top management will also assure that planned activities will be implemented as scheduled.

The majority of the core team (Figure 2-2) and the HED assessment team (HEDAT) members are BSEP personnel and it is noted that a number of the same persons will be on both teams. This arrangement should enhance continuity and coordination of the DCRDR effort.

The core team, as identified by title in the program plan, is multidisciplinary except it does not include instrumentation and control (I&C) engineering or nuclear engineering as is recommended in NUREG-0800. I&C engineering is designated as a support group and its responsibilities are defined, but the question remains as to who will be responsible for the nuclear engineering aspects of the DCRDR.

The reviewers realize that at this point assignments and levels of effort of each review team member will necessarily be only estimates. However, while the program plan has identified a number of positions/groups, described associated responsibilities and, in some cases, specified task involvement, there remains a dearth of information regarding task assignments and levels of effort. For example: Figure 2-3, Task 7, "Conduct-Plant Specific Review (CRDR)," is the primary responsibility of the Lead Human Factors Specialist. Support responsibility is assigned to the Review Team Leader and to the System Integration Team Leader. This broad review task includes a number of specific tasks vital to its completion but there is no description of these tasks, their scope, nor the persons/positions which may be assigned them. Use of guidance provided by NUREG-0800 regarding review team member roles might have helped alleviate this kind of ambiguity.

NUREG-0800 states that the program plan report should contain detailed documentation of the qualifications of the DCRDR team members. As previously mentioned, it is understandable that at this time a number of prospective team members may not yet have been identified. It would seem, however, that the BSEP personnel slated for lead positions would be known and their qualifications available for inclusion in the program plan. In the case of the human factors specialists, even though presently unidentified, it would have been helpful in our program plan evaluation if the qualifications to be required of such prospective team members (consultants) had been indicated, as suggested in NUREG-0800, Section 2.1.2.1.

In view of the fact that the composition of the DCRDR review team is not yet final and the qualifications and experience of the possible members are not evident, it is suggested that the licensee consider developing a review team orientation program such as that described in NUREG-0800, Section 2.1.4.

In summary, the management structure of the proposed DCRDR team seems able to support a successful review effort. The lack of more specific information regarding task assignments and levels of effort makes evaluation of this section more difficult. However, the most important discrepancy is the absence of personnel identification and qualifications. Without this information the reviewers can have no confidence that the review team will, in fact, be multidisciplinary or possess the requisite technical expertise. Therefore, assurance that CP&L will meet this requirement of Supplement 1 to NUREG-0737 cannot be demonstrated.

2. Function and Task Analyses

CP&L's System Function and Task Analysis (SFTA) will be initiated by use of the Boiling Water Reactor Owners Group (BWROG) Emergency Procedures Guidelines (EPGs) which define generic systems and functions, primary actions, information requirements and criteria, and allocate functions between man and machine. An additional generic source to be used will be the functional analysis previously performed jointly by BWROG and EPRI to develop a graphic display system to support the EPGs. CP&L indicates that this analysis resulted in the development of a set of parameter tables pertinent to each EPG step which will be used to help ensure all parameters applicable to BSEP are completely identified. The program plan, however, did not include a sample of these tables nor describe how they were developed. CP&L should furnish this referenced document in order that reviewers can draw conclusions regarding its adequacy.

The program plan indicates (p. 3-14) that the EPGs and the plant-specific EOP technical guidelines will be compared to identify departures from the EPGs required by plant-specific engineering differences and that the EOP technical guidelines will document the bases for departure from the generic EPGs. This process is designed to yield a set of primary, plant-specific operator actions for each emergency response function and contingency represented by the EPGs. It is not clear, however, how the plant-specific EOP technical guidelines themselves were developed. The reviewers cannot determine if they had been previously developed or if they will be developed in conjunction with the process of determining plant-specific differences from the EPGs. If the latter is the case, no information is provided regarding how EOP technical guidelines will be developed. Due to the fact that the EOP technical guidelines will constitute the supporting documentation for all subsequent steps in task analysis, the reviewers are concerned regarding their completeness/degree of detail and validity. The program plan needs to provide an account of how and by whom the plant-specific EOP technical guidelines were developed and verified. Also, the plan would have been more complete if it had mentioned a procedure for integrating task analysis results with the development of the BSEP EOPs as is suggested by this requirement of Supplement 1 to NUREG-0737.

If the EOP technical guidelines are in fact adequate the next logical step, as described in the program plan (p. 3-14), will be breaking the high level requirements out into specific tasks and behavioral elements (e.g., observe, monitor, start, stop, etc.) necessary to accomplish each task. The plan states that each behavioral element will identify the operator action and plant system, component and/or parameter addressed by the action. Additionally, the behavioral element description will include identification of specific control action and information characteristics/criteria such as, permissible bands, limits, graduations, ranges, and timing requirements.

This information will be documented on Action-Information Requirements Details (AIRD) forms (Figure 3-1). The column headings on the AIRD form will specify the item of information that will be used to define each behavioral element. The behavioral element specification will be done by detailed consideration of plant system engineering and operating criteria in relation to the functional objectives of the tasks. Other sources to be used in identification of detailed information and control characteristics/criteria will include systems descriptive data, Technical Specifications and associated analyses.

Regarding the AIRD forms: The reviewers are concerned as to why a column is provided for "Component, Equipment No.". Task analysis is to be conducted independent of the control room but the presence of this column tends to indicate this may not be the case. If this column is not filled in until the control room is being inventoried, the program plan should make this clear. As it is, it appears that definition of operator information and control requirements/characteristics could very well be biased by existing control room equipment, i.e., operator information and control requirements might be so defined as to be satisfied by existing instrumentation and controls. This interpretation of the task analysis methodology would defeat the purpose of this DCRDR activity. More detail in this section of the plan would have avoided this ambiguity.

The AIRD form does not appear to provide sufficient space to record adequate description of the displays annotated by data concerning dynamic range, setpoints, resolution/accuracy, speed of response, units, etc. No space is provided for the description of the needed type of devices.

When the AIRD forms have been completed they will be sorted by task name so that all forms with the same task name will be grouped together. Within each stack the forms will be ordered by step within the EPG (p. 3-15). This aggregate information will be documented on the Action-Information Requirements Summary (AIRS) form (Figure 3-2) to summarize the information and control requirements across tasks and elements.

The reviewers do not understand what is to be gained by the above described sorting and summarizing activities (para C, p. 3-15). We fail to see how the establishment of required operator information and control needs and definition of display and control characteristics will be enhanced, particularly by summarization. Such an approach seems to be in conflict with the program plan statement: "The product of the SFTA process will be a detailed listing of operator information and control requirements based on the summation of the specific requirements associated with each emergency task element" (p. 3-16). This step and its purpose in the task analysis methodology would have been more clearly described in the program.

In conclusion, the licensee's plan for conduct of an SFTA indicates partial understanding of the requirments and a commitment to fulfill those requirments but, until the reviewers can be assured the EOP technical guidelines to be used in conducting the SFTA are complete and verified, we cannot fully evaluate the SFTA plan. Provision of the referenced BWROG-EPRI document is required for reviewers to judge its adequacy. Also, concerns raised regarding specific steps in the task analysis procedure should be addressed by CP&L.

3. <u>Comparison of Display and Control Requirements With Control Room Inventory</u>

The control room inventory will consist of a review of relevant (i.e., based on SFTA results) control room documentation supplemented by control room visits. During these visits information for all components will be recorded on inventory sheets. The availability of needed instrumentation, controls and equipment (based on SFTA results) will be verified on a panel-by-panel and task sequence basis using the control room inventory. Any instrumentation or control requirement that is not satisfied will be documented as an HED.

Suitability of instrumentation and controls will be verified in accordance with guidelines from NUREG-0700 and criteria derived through task analysis (p. 3-18). Consideration will be given to such characteristics as: adequacy of display range, relative location of related components, usability of displayed values, ease of operation, etc. Any discrepancies noted will be documented as HEDs. In some cases HEDs derived from the verification process may not result from failure to satisfy a NUREG-0700, Section 6.0 guideline but rather from task analysis derived criteria. Such HEDs will be documented.

Control room validation will be conducted with emphasis placed on determining the adequacy of the integrated (all instrumentation, controls and associated equipment) control room design for supporting operator task sequences (p. 3-19). Scenarios and task sequences chosen for control room validation will be based on SFTA results to ensure they represent all emergency interface requirements.

Validation will be accomplished via scenarios' walkthroughs conducted at less than real time. This will permit stops, explanations and notation of problems and/or particularly good features. The validation will be primarily to note the effects of previously identified HEDs (to subsequently be assessed) and to identify and document new HEDs discovered during the walkthrough process. The validation activity appears to be adequately planned, however, the use of a checklist or series of questions based on NUREG-0700 criteria would strengthen the approach by helping to guide observations and identify problems.

The program plan description of the inventory process indicates that a successful inventory will result and provide a comprehensive list of characteristics of instrumentation, controls, equipment and HEDs in the control room. The inventory will be compared with information and control requirements identified during the task analysis to identify any availability or suitability HEDs. Also, any extraneous components will be identified which will prove valuable in that they will open up needed panel area. In conclusion, given that a valid task analysis is available and these activities are conducted as described, this requirement of Supplement 1 to NUREG-0737 should be satisfied.

4. Control Room Survey

The program plan states that the control room survey will be conducted in accordance with the guidelines and criteria provided in NUREG-0700, Section 6. Any deviations from the guidelines will be documented (a sample task plan for the Annunciator System is provided in Appendix A, of the program plan) as HEDs and scheduled for assessment. The control room features to be covered by the surveys and the methods of evaluating each (14 total) are listed on pages 1-7, 1-8 and 1-9 of the program plan. Data will be gathered by several types of instruments (checklists, interviews, direct measurement, etc.) as suggested in NUREG-0700. The scope and methodology planned for the conduct of the survey should ensure a thorough and well documented assessment of the BSEP control room as required by Supplement 1 to NUREG-0737.

5. Assessment of HEDs

CP&L describes the approach to assess HEDs on pages 4-1 and 4-2 of the program plan. A select group of team members are to be assigned HED review/assessment/correction as primary responsibilities. The HED Assessment Team (HEDAT) members will include: (1) Lead Discipline Engineer, (2) Review Team Leader, (3) System Integration Team Leader, (4) Lead Human Factor Specialist, and (5) Human Factors Manager. Support to the HEDAT is to be provided by operations, instrumentation and control (I&C) engineering, maintenance and human factors.

HED assessment will involve prioritization/categorization of each HED based on estimates of potential for error and the consequences of errors resulting from the respective HEDs. HEDs related to systems and functions identified as safety related during the SFTA or which increase the probability of an error that could result in violation of Technical Specifications or unsafe operation, or have been previously documented as having caused error will receive the highest rating, i.e., Category 1. According to Figure 4-1, (p.4-6) the criteria for Category II, III, and IV HEDs are: increased potential for error, low probability of error, and not associated with probability of error, respectively.

The Program Plan also notes that while Category IV HEDs are considered optional for correction they will be assessed for their cumulative and interactive effects on all other HEDs and that those Category IV HEDs shown to possess such effects will be recategorized to the appropriate category.

Consequences of HED induced error are said to constitute a portion of HED assessment criteria and the relationship between probability and consequences is clear in the case of Category I HEDs. The relationship between probability and consequences in connection with Category II and III, however, is not clearly defined. For example: How is an HED that has an increased potential for causing an error of minor significance categorized, or how is a HED categorized that has a low probability of causing an error but if the error occurs the result is safety significant? Absence of definitions for these kinds of relations leave the reviewers without an understanding of the assessment of Category II and III HEDs and unable to adequately evaluate the proposed assessment process. Also, the plan could have been stronger had it mentioned the use of a questionnaire (such as that in NUREG-0800) to guide the assessment process.

CP&L has described an approach to assess HED significance that follows NUREG-0800, Section 8.1 fairly closely with the following exception: Criteria for categories II, III and IV have not been defined in enough depth to judge their acceptability. Reviewers are concerned that category definitions are ambiguous and may hamper a smooth and efficient assessment process.

The program plan also addresses a schedule for the implementation of the selected corrections. Figure 4-1 includes the ratings for implementation priority as assigned to each HED assessment category. Accordingly, Category I HED correction is mandatory and implemented at the earliest opportunity, Category II are implemented at the earliest opportunity and are high priority, Category III are implemented at "convenient outage" and are accepted, and lastly Category IV HED corrections may or may not be required. CP&L indicates that these categories will provide a basis for the corrective action schedule, however, other considerations may impact the ultimate date. Such constraints are the integration of corrections with other programs, operations, training, and resources.

In conclusion, CP&L has presented a plan to assess HEDs for significance and to determine their priorities for corrective action. The discussion indicates that the licensee has some understanding of this requirement of NUREG-0737, Supplement 1. Clarification of the process and exact criteria applied to HEDs for all categories could have strengthened the description and lent more credence to the potential success of the DCRDR.

6. Selection of Design Improvements

The selection of design improvements will be the responsibility of the HEDAT. The HEDAT selects corrections for all HEDs regardless of the assigned category. The selection process will begin by determining which HEDs can be corrected by "enhancements, training of operators, and/or procedural revision" (p.4-2). If the team decides that correction by enhancement is not possible, based on reapplication of the needed checklists and/or task analysis, other design corrections will be analyzed. Other corrective actions may include a "simple modification to the communication, lighting or alarm system, or alterations to the control boards" (p. 4.4). CP&L also indicates that the correction selected will depend on resources, cost/benefit analyses, and scheduling estimates. Although CP&L mentions the limitations of cost in selecting design improvements, they indicate human engineering acceptability is also a limitation. Operator training, plant maintenance and documentation needs will also be considered during this activity.

The discussion in the program plan indicates that CP&L has adequate foresight for this phase of the DCRDR. It appears that several design alternatives will be explored based on the many associated considerations that impact the selection of design improvements. All considerations appear appropriate and necessary for this potentially extensive task. If conducted as described the process would result in a complete examination of corrections and meet the requirement of Supplement 1 to NUREG-0737.

7. Verification that Improvements Provide the Necessary Correction and Do Not Create New HEDs

CP&L's program plan addresses the requirements to verify that HEDs are corrected by the selected improvements without creating new HEDs in Section 4.2. It is indicated that while considering multiple alternatives to the correction of HEDs, each approach will be verified by further evaluation using functional analysis, task analysis, and reapplication of the NUREG-0700 guidelines. CP&L states on page 4-5 that "for all HEDs selected for correction, the extent to which each discrepancy will be corrected (by enhancement or redesign) will undergo HEDAT evaluation." As a result of that evaluation, the HEDAT will identify and document any HEDs which are not fully corrected and prepare a justification.

The discussion of these requirements in the program plan is brief but it illustrates CP&L's acknowledgment of the need to evaluate HED corrections to ascertain whether the HED has been resolved, at least in part. The plan to reapply survey guidelines and results of the task analysis should help to verify the success of the correction. However, the reviewers of the plan believe that CP&L should have developed further verification plans and techniques to achieve the purpose of these requirements. For example, the application of the corrections to a mockup or a simulator followed by walk-through/talkthroughs with operators would provide a high degree of confidence in the final design correction selected. This type of technique is particularly necessary so that the selected solutions together will provide a consistent and integrated operator-control room interface. Moreover, the input from operators should assist in verifying the solutions' suitability in the context of actual operations.

In conclusion, CP&L has mentioned an approach toward meeting these requirements, however, that approach, as presented in the program plan, is not adequately developed to ensure verification of corrections. Further preparations for the verification phase should be undertaken by the licensee in order to assure that requirements of Supplement 1 to NUREG-0737 are satisfied.

8. Coordination of the DCRDR With Other Improvement Programs

The program plan submitted by CP&L addresses the integration of the DCRDR with other activities on page 1-3. It indicates that the organization of the plan considers the overlap and interfaces between the related activities. Accordingly, CP&L mentions use of the BWR EPGs as a basis for the function and task analysis, however, integration of the results of the analysis with EOP development through an iterative process is not specifically mentioned. Scheduling of corrections will be coordinated with other NUREG-0737, Supplement 1 programs such as Reg. Guide 1.97 instrumentation. Operator training is mentioned as a consideration during the correction phase of the DCRDR. CP&L also mentions the need for document control during the DCRDR which will facilitate information exchange between the related programs. Finally, CP&L has assigned the "Lead Discipline Engineer" responsibility for the coordination effort which may ensure the needed overlap of programs is carried out.

In conclusion, CP&L's program plan demonstrates an awareness of the required coordination of the DCRDR with other programs. However, further discussion of the specific way to overlap all programs should have been provided. Also, the provision of a schedule or milestone chart illustrating the overlap among the programs would have strengthened the program plan.

9. Other

CP&L's program plan indicates that one of the control room review activities is an operating experience review. This review will encompass structured interviews with operators and an operations personnel survey. Questionnaires and checklists have been constructed to guide this activity and will cover specific guidelines contained in Section 6.0 of NUREG-0700. This review stage should generate important findings and prove to be a valuable tool for the DCRDR. CP&L is encouraged to also consider a review of Licensee Event Reports that may have relevance to BSEP.

CONCLUSIONS AND RECOMMENDATIONS

CP&L has submitted a program plan that addresses all of the requirements of Supplement 1 to NUREG-0737 for the conduct of a DCRDR. Although the plan describes adequate methodologies for most of the DCRDR requirements, it is recommended that an in-progress audit be conducted before the program is too far underway. This audit will afford CP&L the opportunity to clarify and address concerns raised in this evaluation and to receive NRC feedback regarding the likelihood of the plan's success to guide a DCRDR. An audit agenda is presented below which details the areas we believe merit further discussion.

- Qualifications and Structure of the DCRDR Team

  1. Identity, qualifications and levels of effort of the core review team members and the HEDAT members.

2. Inclusion of a nuclear engineer on the core review team.

- o System Function and Task Analyses

  1. How and by whom plant-specific EOP technical guidelines were developed and verified.
  2. Integration of the task analysis with the development of the new EOPs.
  3. The procedure to complete the AIRD forms.
  4. The purpose of sorting AIRD forms and the documentation of the AIRS.
  5. Provision of referenced source document for the functional analysis performed by BWROG and EPRI.

- o Assessment of HEDs
  1. Criteria for assessment of HEDs definition of categories.
  2. Use of a questionnaire to assess HEDs.

- o Verification of Design Improvement
  1. Technique to test proposed changes.

- o Coordination of the DCRDR with other programs
  1. Milestone schedule
  2. Envisioned integration of the DCRDR with other initiatives.

REFERENCES

1. Carolina Power and Light Company, Brunswick Steam Electric Plant, Control Room Design Review Detailed Program Plan and Implementation Guidelines, December 1984.

2. Supplement 1 to NUREG-0737 - Requirements for Emergency Response Capability (Generic Letter No. 82-33), U.S. Nuclear Regulatory Commission, December 17, 1982.

3. NUREG-0700, Guidelines for Control Room Design Reviews, U.S. Nuclear Regulatory Commission, September 1981.

4. NUREG-0800 (Standard Review Plan), Revision 0, Section 18.1 and Appendix A to Section 18.1, September 1984.

5. NUREG-0660, Vol. 1, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980; Revision 1, August 1980.

6. NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980.

7. NUREG-1000, Generic Implications of ATWS Events at the Salem Nuclear Power Plant, April 1983.

8. Generic Letter 83-28, Required Actions Based on Generic Implications of Salem ATWS Events, July 8, 1983.

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